

## VIRGINIA GIS REFERENCE BOOK

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General Application Name: Public Works/Service Authority

Product / Service / Function Name: Environmental Impact Analysis

P/S/F Description:

An environmental impact analysis (EIA) is generally conducted during the planning stages for a new project or environmental alteration. The Environmental Protection Agency (EPA) as well as other federal and state agencies often require that an EIA be completed first to determine the positive or negative impact that the new project may have on the environment as well as propose alternative actions. An EIA utilizes a composite of diverse data or parameters influencing the environment including land, air, water resources and their interaction with flora, fauna and human influences. EIA studies are carried out to ensure the compliance with federal/state/local government environmental laws. GIS can be a powerful tool for studying effects on the environment because most of the data required for an EIA is geographically referenced and GIS has the analytical capabilities to create “what if” scenarios for environmental impact.

Product / Service / Function

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### 1. Spatial Data

#### *Minimum Requirements*

General Description	Data Layer
Natural Features	Floodplains
	Soils
	Streams
	Watersheds
	Lakes
	Wetlands
	Vegetation
	Wildlife habitat
Socio-political	Municipal boundaries
	Land Use
	Demographics
	Zoning
Planimetrics/Land Base	Parcels
	Orthophotography
Transportation	Roads
	Railroads
	Parking lots
	Driveways

#### *Optional Enhancements*

General Description	Data Layer
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Industrial	Mines
	Quarries
	Pipelines
	Industrial Sites
	Hazardous Waste Sites
	Landfills
	Drilling Operations
	Power Plants
Natural Features	Geology
	Geomorphology
Planimetrics/Land Base	Satellite Imagery
Socio-Political	Cultural/Heritage Locations

## 2. Attribute Data –

### *Minimum Requirements*

General Description	Field Name
Floodplains	Level (100-year, etc)
Soils	<i>See Soils Analysis topic</i>
Streams/Lakes	Water Quality
Watersheds	Area
	Drainage outlet
Wetlands	<i>See Wetlands Inventory topic</i>
Vegetation	Species
	Area
	Endangered status
Wildlife	Species
	Extent of habitat
	Endangered status
Land Use	<i>See Land Use topic</i>
Industrial	Name of facility
	Known pollutants
Demographics	Population

### *Optional Requirements*

General Description	Field Name
Industrial	Name of facility
	Known pollutants
Geology	Formations/Faults
Socio-Political	Name of site

### 3. Data acquisition Options (integrated with VBMP digital orthos)

An environmental impact study should begin with a complete search of Federal GIS data sources available for the local area. Data acquisition for EIA is a time consuming process as each EIA is a unique undertaking and highly subjective in analysis as well as the different spatial and attribute information required for the area of study. While the scale of the data may vary, in most cases, these Federal datasets will be sufficient. However, if the study area is rather small, a field survey may still need to be conducted for a required data layer in order to detect the small variances that occur.

A good place to begin searching and downloading environmental data is at the Federal Geographic Data Committee (FGDC) web site < <http://www.fgdc.gov/clearinghouse>>. This provides a “one stop shop” for all Federal GIS data. It provides access to data from the USGS, USDA, EPA as well as many other smaller, statewide collections. Planimetric data such as utilities, buildings, land use, streets, etc. are maintained at the county or city level and can be utilized to support EIAs.

Once data has been collected, thematic mapping should be organized according to the legislative requirements of the project. Depending on the nature of the study (e.g., Environmental Assessments, Environmental Impact Analysis) specific criteria will need to be analyzed and documented to support the investigation. Generally speaking, these requirements may need to address the Clean Water Act, Clean Air Act, or Threatened and Endangered Species legislation.

Orthophotography is also an integral component of an EIA study as it provides a means to create data by interpreting features and by also providing a “bird’s eye view” of the study area. Orthophotos are also useful for showing changes on the landscape over time or to help visualize future impacts.

### 4. Data conflation Options (integrated with VBMP digital orthos)

Data conflation is a process by which two digital data layers, usually of the same area at different points in time, or two different data layers of the same area, are geographically “corrected” through geometrical and rotational transformations so that the different layers can be overlaid on one another. Also called “rubber-sheeting,” this process allows a technician to adjust the coordinates of all features on a data layer to provide a more accurate match between known locations and a few data points within the base data set. A good base layer to use for data conflation is the VBMP orthophotos since many features can be seen or interpreted. The need and processes for conflation varies between sets of data, users, and feature types. Any dataset that is updated independently by different departments can be consolidated through conflation. Within most local governments, individual departments are responsible for maintaining specific datasets within their expertise; therefore, conflation is not often necessary. Often, reprojecting the data into a different coordinate system will take care of the misalignment of different data sets. Most industry-standard GIS software has the ability to perform data conflation.

Since the data for an EIA is from many different sources, data conflation is an important step. For instance, data layers such as wetlands, soils, and watersheds will not align with each other until conflation has taken place. The VBMP coordinate system should be the standard for EIA data layers.

## 5. GUI / Programming options

There are many options for developers of an EIA application. Two avenues within this development track are:

- Standard GIS desktop software that can be customized to the user's needs
- Hiring a consultant to develop a custom system from scratch.

Using a standard GIS software package often requires a significant amount of training and customization. Whereas the initial cost may be lower, the time invested in learning these solutions may generally increase the overall expense of implementation. However, standard GIS software packages deliver more robust data integration, analysis, and cartographic capabilities than do other specialized commercial applications. They have a greater user support infrastructure that allows users to overcome problems quickly. Options for using an existing, industry-standard GIS software application that can be customized for environmental impact analysis include those listed in the following table:

*Standard GIS Software Vendors:*

<b>Vendor</b>	<b>Software</b>	<b>Web Address</b>
ESRI	ArcView 3.x	<a href="http://www.esri.com">http://www.esri.com</a>
ESRI	ArcGIS 8.x	<a href="http://www.esri.com">http://www.esri.com</a>
MapInfo	Professional 7.0	<a href="http://www.mapinfo.com">http://www.mapinfo.com</a>
Intergraph	GeoMedia 5.0	<a href="http://www.intergraph.com/gis">http://www.intergraph.com/gis</a>
Autodesk	Map 5.0	<a href="http://www.autodesk.com">http://www.autodesk.com</a>

Another option for developing and implementing a GIS-based EIA application is to contract with a consultant. This option makes certain that a product will fulfill a jurisdiction's specific requirements. A consultant will be able to develop an application that works with the wide range of hardware and software that are currently in use within local governments within Virginia. Also, training and follow-up user support is often provided at a much more substantial level than with other options.

The development projects that prompt an EIA are diverse and require different data sets and outputs. They also require different types of analyses depending on what feature is being studied. Some possible functions for an EIA application are listed below:

- Identify potential sensitive water and land resources.
- Determine whether or not building a new wetland will encourage new bird populations to inhabit an area.
- Calculating the potential environmental risk of building a new power plant next to a river.
- Determine how many species may be displaced from their habitat for a new business park to be developed.

## 6. Internet Functionality and options

The Internet has proven itself as a viable solution for local governments to centralize the maintenance and management of services and data. As more local governments are implementing Web-based solutions, they are finding that the Internet requires them to change the nature of an application or its usefulness. Through the flexibility of an Internet solution, software

can be easily updated, and users gain greater accessibility to the applications and information they need for their specific tasks through simple, user-friendly interfaces.

While desktop applications are mainly for staff and “power users,” an application can be deployed on the Web for the general public. While a fully functioning application may not be reasonable to display on the Internet (depending on the type of data being analyzed) the outputs of the EIA could be presented on the Web, along with other data from the municipality. For example, an interactive map of a proposed airport could be displayed for the public’s information. GIS software vendors have products that can be customized in-house or by a consultant to provide Web GIS applications on the Internet, over an intranet or via wireless network. The table below shows GIS vendors and their Internet mapping solutions.

#### *GIS Internet Solutions*

<b>Vendor</b>	<b>Internet Software</b>	<b>Web Address</b>
ESRI	ArcIMS	<a href="http://www.esri.com/software/arcims">http://www.esri.com/software/arcims</a>
MapInfo	MapXtreme, MapX	<a href="http://www.mapinfo.com">http://www.mapinfo.com</a>
Intergraph	GeoMedia WebMap	<a href="http://www.intergraph.com/gis/gmwm">http://www.intergraph.com/gis/gmwm</a>
Autodesk	MapGuide	<a href="http://www.autodesk.com">http://www.autodesk.com</a>

## 7. Technical Requirements

#### *Minimum Technical Requirements*

At its most basic level, a GIS application for supporting EIA studies can be run on a single, stand-alone workstation. This workstation would have a hard drive that stores all of the spatial data layers and other associated tabular data. A typical workstation running off-the-shelf software should have the following minimum specifications:

Processor:	Pentium 3, 450 MHz
RAM:	128MB SDRAM at 133MHz
Hard Disk:	20GB (min.)
Monitor 1:	19"
Floppy Drive:	3.5"
CD-ROM:	12x/8x/32x CD drive
Modem:	56K
OS:	Windows 2000/NT/XP
Office:	Windows 2000 Professional
Printer:	8x11 office-grade color printer

#### *Optimum Technical Requirements*

A more data analysis intensive EIA application may require multiple components, including servers and desktop workstations. Some examples specifications of the necessary equipment are listed below:

#### **Server**

Processor:	Min. 2x Processors, 1.7 GHz, 512K cache
RAM:	Min. 2x 512MB RIMMS

Hard Disk:	Min. 2x 80GB +RAID
Monitor 1:	19"
Floppy Drive:	3.5"
CD-ROM:	12x/8x/32x CD drive
Modem:	56K
Network Card:	10/100 mbps

#### **Workstation**

Processor:	Pentium 4, 1.5 GHz
RAM:	512MB SDRAM at 133MHz
Hard Disk:	20GB (min.)
Monitor 1:	19"
Monitor 2:	17"
Floppy Drive:	3.5"
CD-ROM:	12x/8x/32x CD-RW drive
Modem:	56K
Network Card:	10/100 mbps
OS:	Windows 2000/NT/XP
Office:	Windows 2000 Professional

#### **Other Components**

Printer:	8x11 office-grade color printer and 8x11 production b/w printer
Plotter:	HP DesignJet 1055CM
Tape Backup:	Tape Library Server
UPS:	APC 1400 (or other similar)
Scanner:	11x17
Handheld:	Compaq IPAQ
Network:	T1

### **8. Administrative/Management Requirements**

At the beginning of the application development process, the assigned project manager from the particular municipality should consider completing some, if not all of the following tasks that relate to the administrative requirements of a GIS-based EIA application:

- Determine, with or without the assistance of a consultant, the preliminary vision and goals of the project.
- Coordinate an initial meeting with the stakeholders (i.e. the Board of Supervisors, local/state environmental agencies, planning department, etc.) where the vision and goals of the project are expressed and the background of GIS technology is described, if needed.
- Coordinate with other municipal agencies for data sharing provisions.
- Determine a mechanism of communication to keep the decision-makers aware of the progress of the project.
- Develop a basic understanding of the available precedents in the region/state and research the available technologies that can be applied to the project.

Upon project completion, a basic GIS-based EIA application will require very little administrative support. Administrative tasks may include loading or upgrading new versions of

the software or patches, providing for constant data flow from the source database, and maintaining yearly support contracts on the hardware and software. However, once the system becomes distributed as an enterprise solution to many users throughout a department or deployed on the Internet, there are various other management requirements that need to be fulfilled on a weekly or monthly basis.

At the point where the system grows beyond single desktop users, a devoted administrator or system manager needs to be established. This is essential for the following reasons:

- The system will now be interfacing with other technology systems already in place. Therefore, someone will need to maintain contact with the technology personnel that maintain these systems.
- The manager needs to put into place training schedules to maintain user knowledge of the system.
- Funding will undoubtedly be required to either maintain the system long-term, or continue to expand the system, which requires funding research and applications for grants.

#### 9. Costs:

<b>Hardware</b>	<b>Typical Unit Cost</b>
Minimum Workstation	\$2,000
Optimum Workstation	\$3,200
Laptop	\$2,400
Web/FTP Server	\$8,500
Database Server	\$12,000
Data Warehouse Server	\$18,000
Backup Server	\$5,800
Printer (8x11 color)	\$700
Printer (8x11 b/w production)	\$2,000
Plotter	\$12,000
Tape Library	\$5,000
UPS	\$700
Scanner	\$1,500
Handheld	\$300-\$700

<b>Software (all prices included license)</b>	<b>Typical Unit Cost</b>
Standard GIS desktop software	\$700-\$10,000
Web-based vendor application	\$15,000-\$25,000
Customized web-based vendor solution	\$20,000-\$100,000

<b>Miscellaneous</b>	<b>Typical Unit Cost</b>
Training - focused vendor training (per person)	\$700-\$1,000
Training - general GIS	\$700-\$1,200
Licensing-desktop	\$100-\$500
Licensing-webapp (1st CPU)	\$7,500-\$12,000
Maintenance (per year)	\$8,000-\$15,000

## 10. Standards / Guidelines Summary

- EIA involves the combination of diverse data types that should be converted to one single projection/coordinate system.
- Acquire input from all departments who will be involved in funding and/or utilizing the application before proceeding with the application design.
- Consider integrating GIS functions for EIA with other environmental functions such as wetlands inventory and soils analysis.
- Develop a detailed Quality Assurance/Quality Control (QA/QC) procedure for reviewing the accuracy of the GIS data and its attributes.
- Maintain data in the VBMP standard coordinate system (Virginia State Plane, NAD 83, Survey Feet).
- Create metadata (standard information about GIS data) for each data layer. Metadata tracks the date, origin, coordinate system, and other such information for data layers.

## 11. Startup Procedures/Steps

There should be a minimum of eight steps involved with developing a GIS-based EIA application, after funding is in place to support the project. The steps can be performed in-house or by a consulting team.

The first task is to complete a detailed Needs Assessment. This process gathers information regarding existing operational procedures, hardware and software, GIS data, and personnel needs. It should include interviews of key individuals throughout the local government agency and other related government departments to obtain a comprehensive view of the agency's operations, and where GIS might improve them. Basic GIS concepts should be discussed and illustrated to those interviewees that have little prior understanding of GIS. A comprehensive Needs Assessment should then be compiled from the results of the interviews. This document explains the various requirements for an EIA application in the following areas: personnel needs, spatial data development needs, applicable spatial analysis techniques, basic system requirements, including preliminary, general hardware and software recommendations, and training needs.

The second task is to develop a functional requirements document for the proposed application. This document should describe, as completely as possible, all of the technology and functionality that is to be included in the system. This document is used by the local government agency, or its consultant, as the blueprint for the GIS application or system.

- Hardware specifications
- Software purchases
- Detailed descriptions of work-flow, and examples of the graphic user interfaces
- Describe each tool that is part of that graphic user interface, and its functionality
- Describe how data would flow between the different databases and data warehouses, if applicable
- Describe the redundant security measures that will be put in place to make certain of data integrity and confidentiality, when applicable
- Analytical techniques that the application/system provides the user for EIA functions
- Describe each of the potential products (reports, maps, charts, summary tables) that the user will be able to generate within the system



The third task should be to compile or develop spatial data that can be used by the evolving application. Data can be gathered from a number of online sources, as well as county/city departments. The data layers gathered and maintained should match at least the minimum list provided in Section 1 of this document and can be acquired through the methods described in Section 3 of this document.

On completion and acceptance of the functional requirements document and the development of the spatial and attribute data, the system development and test phase can begin. During this time, the application will be customized as it was outlined in the functional requirements phase. The local government agency should require periodic reviews of the application at particular milestones, such as 50% and 75% completion. This will make certain that problems with the application will be recognized early in the development process, and that the local government agency remains a part of the development process throughout the project timeline.

When the application is nearing completion, it should be installed and tested in the environment in which it will ultimately be used. This allows the users to test the system alongside the application developers, and determine any system integration problems that might arise. It also gives the developers the opportunity to test the application's functionality in a real-world situation. This testing process should be as comprehensive as possible. Each process detailed within the functional requirements should be tested and evaluated at this point.

User training commences once the application reaches completion and is fully documented. Different levels of tutorials and system documentation should be developed depending on the hierarchy of users. Time should be spent at this stage of the project with each potential user of the system to make certain that the proper education occurs. Training should be done through lessons that use real-life examples of system application. This strategy greatly enhances users' ability to apply the functionality to their jobs.

The next phase of the project should include a document that describes a future plan for wider system development. This document accomplishes two goals. The future plan gives the local government agency ideas on how the system might grow to assist other facets of its business practices. Secondly, it provides the agency with a ready-made grant proposal for applying for potential funding sources.

The final phase of a successful implementation of a GIS-based EIA application is ongoing technical support. The local government agency should always include this contingency within its cost estimates of a project for a minimum of three months after a system has been put into place. No matter how effective an application appears, problems and system changes inevitably impact the functionality of an application.

## 22. Estimated time line and/or implementation (stand alone) schedule

Phase	Duration
RFP/Contract process (construction, posting, proposal acceptance, review, award of contract)	4 months - 1 year
Needs Assessment	1 month
Data Development	3-8 months
Customized Application Development	3-8 months
User Training	½ month

Plan for Future Development	¼ month
Ongoing Support	3 months

### 23. Best Practice Examples in Virginia

City of Hampton  
 Public Works  
 22 Lincoln Street, 4<sup>th</sup> Floor  
 Hampton, VA 23669  
 757-727-8311  
[www.hampton.va.us/publicworks/engineering\\_services\\_gis\\_services.html](http://www.hampton.va.us/publicworks/engineering_services_gis_services.html)